CHAPTER THREE
SPECIFICATIONS AND SIMULATIONS

Introduction

This chapter outlines the main events of the project as it was implemented at the RCA and the King's Fund from June 1963 until February 1967, when the final specification was published by the Fund. A number of investigative techniques were employed and I shall give a largely descriptive account of these, leaving more detailed consideration of their implications to Chapter Six. Contingent factors, such as the availability of resources, modified the methods. Time, in particular, was in short supply. Throughout the project there was, it seems, some discrepancy between the King's Fund's expectations of when the working party would report and the timescale the RCA team would have liked to complete their intensive investigations.

The period may be considered in two phases. First came an initial, 'information gathering' phase which resulted in just under a year in the draft user specification of April 1964.[1] Although relatively brief, this period was decisive for the final form which the specification took. A number of choices were made which excluded certain options and enshrined others. Despite many assertions that rigorous scientific methods were followed throughout, it was largely to the problem *after* it was constituted in this first phase that formal and abstract techniques were applied.

---

[1] Royal College of Art, Studies in the function and design of non-surgical hospital equipment, Report No 12, *General purpose hospital bedstead: user specification*, April 1964.

The second phase comprised nearly three years of model and prototype building, field trials, and revisions to the user specification. It involved the construction of 'simulated beds'; both small scale model beds as aids to the designers and advocates to the Working Party, and prototype beds or 'hypotheses' which were 'inserted' into the real world, as a form of controlled experiment. This was a simulation of everyday use in the real world; a world that both was, and yet was not, identical to it. Simulation was a key technique in operational research that was adopted and adapted in widely disparate fields, with different degrees of selection and abstraction. Flight simulators for training pilots, game theory consoles and 'role play' techniques used in management courses all shared similar theoretical assumptions, and origins in the cyborg sciences of the 1950's and 60's.

Increasingly, however, this phase of the project became about negotiating the social world well beyond the confines of what went on within any controlled experiments. Getting the details of the specification right was important to the RCA team, but so was anticipating and circumventing potentially damaging opposition, whether from their sponsors or further afield. Pre-empting opposition, (much of which was expected to be part of opposition to standardisation per se), and promoting the specification, and by implication or otherwise the policy of standardisation itself, were rather different enterprises from fine-tuning the content of the specification. After a certain point in the project, it seems likely that investment by interested stakeholders was such that widespread acceptance of the specification became more important than its precise content. (This had probably been true from the outset for certain groups.) Rhetorical claims about a scientific and rigorous design method served this

purpose very well among certain key audiences, and were increasingly brought into play.

Specifications

'Information gathering' was an essential initial stage in Archer's method. Three types of formal exercise were carried out: a literature search, the holding of 'juries' or focus groups and a television survey. The results of the first and last were written up as separate reports by the RCA team.[2] Despite the fact that the literature search was described as recording 'one thousand five hundred items of information', the team were disappointed at the lack of material they considered relevant to hospital bed design published within the previous decade; 'very little . . . was firmly based on experimental data'.[3] The data amassed included anthropometric and ergonomic findings, bed standards and specifications from various countries, and the few comparative studies of hospital beds which had been carried out elsewhere during the period.[4] For many issues relating to

[2]Royal College of Art, Studies in the function and design of non-surgical hospital equipment, Report No 16, *General purpose hospital bedstead: a list of sources of information*, July 1964 and Report No 10, *Result of a television enquiry on certain features of the hospital bedstead*, June, 1964.

[3]Ken Baynes, *Industrial Design in the Community*, London, Lund Humphries, 1967, p.47.

[4]Principal among these were two studies carried out in the US: Warren L. Ganong, *Comparative evaluation of hospital beds*, Pittsburgh, Pittsburgh University Engineering Research Division, 1960, and Harold E. Smalley, *A comparative evaluation of eight bed types*, Atlanta, Georgia Institute of Technology, 1962. Smalley's work was a continuation of Ganong's investigations when the University of Pittsburgh programme moved to Georgia Institute of Technology. Both investigations were done under the auspices of 'methods improvement', a part of 'industrial engineering' (the American term for work study). See Harold Smalley and J.R. Freeman, (eds) *Hospital Industrial Engineering: A guide to the implementation of hospital management systems*, New York, Reinhold, 1966, pp.59-80 for an account of the origins of and early programmes in this field.

hospital bed design there was apparently no published information, and the team looked to a second technique.

A number of meetings were set up between the RCA team and groups of professionals considered to have pertinent views on hospital bed design. At the time they were referred to as 'juries', or, since nurses greatly predominated, 'nurse juries'. These were to 'brainstorm' the topic. A typical 'nurse jury' held in September 1963 consisted of two matrons, a ward sister and a nursing research officer from the Ministry of Health.[5] In line with Archer's predilection for prior definitions, the meeting began by seeking agreement as to the purpose of a hospital, the aims of the NHS and the function of nursing care. Perhaps fortunately, members of the jury showed no inclination to disagree with definitions of these taken from various official sources. Because Archer considered that potential users should be asked to express their views about an artefact in terms of desired attributes, subsequent discussion was organized around individual properties which a hospital bedstead could or should possess. These included, for example: mobility, a backrest, adjustable height, cross (ie side to side) tilt and a divided mattress (one with an upper section that could be raised.). Notes for each were kept on individual cards. From cards completed during this particular jury it appears that, on the subject of height adjustment for example, they considered just a high and a low height necessary, 'adjustable height was important but more for the chronic sick'. They were also keen on cross tilt, considering that 10 degrees lateral tilt of the mattress platform in each direction would do much to ease the

[5] AAD/1989/9, BoxA, Document 985, Notes of a meeting on 3.9.63. Another, on 20 August 1963, had comprised two matrons, one ward sister and a nursing research officer. In general, London teaching hospital staff were strongly represented, although those from non-teaching hospitals were also involved.

nurses' dilemma of whether to cause patients disturbance and sometimes pain by turning them, or risk the production or worsening of bedsores. The number of these juries held was small. They were not intended to be large statistical samples but to identify attributes which the bed might possess and pointers for further research in the literature.[6]

As such, the process might be regarded as the first of a number of stages of elimination, of certain interests and certain design possibilities. Hospital beds which could be adjusted by the patient, and beds with profiling mattresses (divided into three or more sections each of which could be moved independently) were available, if expensive. At the more futuristic end of the market, hospital beds with integral ladders, lavatories or air-conditioning had all been produced.[7]

Very rapidly, however, the team had narrowed down their enquiry to twelve questions which they considered essential but which they were unable to answer on the basis of the literature search or the nurse juries. Given their concern with amassing large amounts of empirical data it was perhaps unsurprising that they turned to survey research, in the form of a structured questionnaire, to provide the 'definitive' answer to these questions.[8] The 1960's were the heyday of the social survey. Its position as

---

[6]Interview, Bruce Archer, 9.5.99.

[7]An air-conditioned hospital bed was shown at the *Britain Can Make It* exhibition at the Victoria and Albert Museum in 1946. See the illustration in Carlo Pirovano (ed) *A History of Industrial Design, Vol 3, 1919-1990*, Milan, Electa, 1992, p.187. For a history of hospital bed designs and a survey of those available in 1962, see Anthony Wylson, 'Ward Furniture: 1, Beds', *Architectural Review*, 132, 1962, pp.64-74.

[8]The questions concerned height adjustment, pedal operation of this facility, design of backrest and footpiece, tilt, stowable safety sides, integral bed stripper (a shelf for bedclothes), the movement of beds, giving of anaesthetics in bed, cross infection issues and 'whether hospitals could use a bed of this basic specification'. BBC Archives, File script, *Panorama*, 3.2.64.

the research tool par excellence of empirical sociologists, and its association with scientific method, had been established by the work of Paul Lazarsfeld, Samuel Stouffer and other U.S. sociologists involved in survey projects such as that known as *The American Soldier.* Reviewers responded to the latter as:

. . . 'the new social science . . . the rigorous testing of explicit hypotheses on largely quantified data accumulated by structured observation in empirical situations approximating . . . the model of controlled experiments'.[9]

Applications such as market research and opinion polling used 'the survey technique', albeit in a simplified form. In Britain, the planning needs of the welfare state increased funding and opportunity.[10] A growing critique of survey methods from some sociologists in the 1960's did little to diminish their use.[11] Away from such academic debates, surveys produced useful, quantified, results. 'How to do it' handbooks were available, including several intended for practitioners in disciplines outside sociology and psychology who wished to avail themselves of the technique.[12] None of these, however, covered the precise procedure that Archer intended to use: this he dubbed a 'televisual' survey.

It was Archer's view that 'a combination of a questionnaire and

---

[9]Platt, *A history of sociological research methods in America*, p.60.

[10]The most comprehensive historical account of the survey is Jean M. Converse, *Survey Research in the United States*: *Roots and Emergence 1890-1960*, Berkeley, University of California Press, 1987.

[11]M. Benney and E. Hughes, 'Of sociology and the interview' in N.Derzin (ed), *Sociological Methods*, New York, McGraw-Hill, 1978, pp.19-33.

[12]Stanley L Payne, 'The Art of Asking Questions', Princeton University Press, 1951 was a much cited handbook. For the medical field, see A.E. Bennet and K. Ritchie, *Questionnaires in Medicine*, Oxford University Press for the Nuffield Provincial Hospitals Trust, 1975.

television' would represent 'the most effective means for recording opinion and inducing general laws for a consensus of opinion on certain matters'.[13] Other benefits were not overlooked. 'A well presented programme would make hospitals, especially those in the provinces, feel they had been adequately consulted in the drawing up of a specification'.[14] The idea was certainly novel. Since the advent of regular television broadcasting in Britain in 1953, no such attempt appears to have been made, possibly because researchers doubted their effective autonomy in such an undertaking. Perhaps naively, Archer assumed that 'as this enquiry is to be transmitted as part of a topical magazine programme (it) may be presented straightforwardly with the minimum of "build up" and staging'. He considered that 'A sober presentation, fully under our control is an absolute necessity if the TV programme is to be mounted'. The topical magazine programme in question was *Panorama* which, somewhat surprisingly, the BBC had suggested when approached by Archer. *Panorama* (it is still running) was a 'flagship' news and current affairs programme. As such, it was highly prestigious, but also subject to the vagaries of the day's events.

Preparation for the programme by the RCA team was meticulous. Cardboard cut outs of the bed parts to be demonstrated were made, painted grey overall, but with the parts to which attention was being drawn during any particular question picked out in brighter colours. The format of the broadcast was to consist of the questionnaire being read out by Archer, while the relevant part or operation of the bed was demonstrated with the cardboard models. The script was timed to the last second. It ran, as

---

[13]AAD/1989/9, Jobs 7 and 13, 'The TV Presentation', Bruce Archer, 21.11.63.

[14]AAD/1989/9, Jobs 7 and 13, Box A, 'Trial by Television'.

agreed with the producer, for precisely twelve minutes. The 1,000 hospitals of more than sixty beds asked to participate in this 'bold venture in the use of modern communication aids' had been sent the questionnaires in advance. Some were requested to organize mixed groups of hospital staff to complete them while they watched the programme, others to distribute questionnaires to individual staff members. Some 20,000 hospital staff were involved.

The programme was publicised in advance in the hospital press, and a fair amount of interest engendered, including a suggestion (not taken up) from the Canadian Nursing Association that they be allowed to participate via Telstar.[15]

The RCA team's hopes were high on the evening of 3rd February 1964 as, throughout the country, nursing, medical and administrative staff gathered around hospital television sets. At the last moment, however, disaster struck in the form of the Soviet Foreign Minister, visiting Britain to celebrate the 40th anniversary of British recognition of the Soviet Union. Panorama secured an interview with the Minister which took half of the time allocated to the bed feature. Instead of twelve minutes of carefully timed questions, interspersed with explanatory diagrams and film, cuts made half an hour before transmission resulted in loss of almost all the explanatory material. After sitting through most of the programme, viewers were merely shown a close up of the questionnaire and given some 'fatherly advice on how to fill it in'. To add insult to injury, nearly a full minute at the beginning of the item was taken up with 'an initial sequence of a scantily clad model rolling about on a bed.' The background music for

---

[15] A/KE/PJ/17/1, memo 24.10.63. Telstar was the first active real-time communications satellite, used from 1962 to transmit television pictures across the Atlantic.

this was a humorous song about insomnia.[16] The broadcast was a great disappointment to the team and potentially highly damaging to the project, particularly since it was only recently that the RCA team had become formally associated with the King's Fund Working Party. Letters of complaint quickly appeared from hospital staff. A typical example, from the German Hospital in London, protested at 'the time-wasting fatuity' of the programme, which was considered 'an insult to our intelligence.'[17] Only prompt action on the part of the King's Fund and the RCA prevented a major public relations disaster. After an emergency meeting of the Secretary of the Fund with Bruce Archer and Irfon Roberts a letter was hastily sent by Archer to all participating hospitals as well as to the medical and nursing press. It expressed grave distress at the 'circumstances beyond our control' which had resulted in cuts to the script.[18] Lord McCorquodale, Chairman of the Fund, and Misha Black complained to the BBC.[19] Hospitals were persuaded to return the questionnaires, albeit incomplete. Five hundred groups of staff and nearly seven hundred individuals did so.[20] The team considered that the answers to nine of the

---

[16]BBC Archives, Broadcast script, *Panorama*, 3.2.64. The song began: 'When you're lying awake with a dismal headache, And repose is tabu-ed by anxiety, I conceive you may use any language you choose, To indulge in without impropriety . . . and continued in the same vein.

[17]See, for example, Letter, 'Hospital Beds on "Panorama" ', *British Medical Journal*, i, 1964, p.559.

[18]Letter, ' "Panorama" Programme on Hospital Bedsteads', *British Hospital and Social Service Journal*, March 13,1964, p.334.

[19]A/KE/PJ/17, KFWPHB Minutes 17.3.64, Items 25 and 26a.

[20]Royal College of Art, Studies in the function and design of non-surgical hospital equipment, Report No 10, *Result of a television enquiry*, p.2.

twelve survey questions were 'valid' without the televisual explanation.[21] In possession of these answers, they proceeded to compile the draft user specification.

These then were the three formal methods of information gathering, the results of which were subsequently much quoted in support of the specification. But the kind of information gathered, and indeed the definition of what constituted relevant information, depended on how the design problem was formulated, and on preconceptions as to how it would be solved. Inevitably, these came from the assumptions, prior experience, tacit knowledge, disciplinary perspectives and personal and institutional interests of key participants, none of which were the subject of overt consideration in the method of arriving at the user specification. As Horst Rittel put it in 1972, 'First generation methods', of which Archer's was one, 'seem to start once all the truly difficult questions have been dealt with already'.[22]

Less than two months after receiving the replies to the television enquiry, the RCA team produced the first version of the draft user specification, in April 1964. In it, the general purpose hospital bedstead was still defined as 'one suitable for the majority (say 60%) of patients being nursed in the ordinary wards of general hospitals. The specification listed thirteen 'roles performed by the bed (not in order of importance)'. They were:

1 Examination table
2 Focus of nursing

---

[21] A/KE/PJ/17, Bruce Archer's Report to KFWPHB, 17.3.64.

[22] Horst Rittel, 'Second-generation Design Methods', in Cross, *Developments in Design Methodology*, pp.317-327:322.

3 Treatment table (without apparatus)
4 Workbench (with apparatus)
5 Trolley for long travel
6 Social centre
7 Daybed or chair for rest (including occupational therapy)
8 Place for sleep
9 Obstruction (to other activities, including cleaning)
10 Thing to be cleaned or maintained
11 Place for assimilation (nourishment)
12 Place for excretion
13 Place for daily toilet

There followed a list of ten 'Bed elements':

1 mattress or pad element
2 mattress support element
3 frame element
4 headpiece element
5 footpiece element
6 backrest element
7 safety sides
8 bed stripper
9 other fixed features
10 attachments

Then came, for each bed element, specifications for its function, structure and dimensions. Appendices listed the team's evidence in support of the specifications. Broadly, this was of two kinds. Where possible, anthropometric and ergonomic data were cited, the latter often extrapolated from findings in other contexts.[23] Otherwise, reference was usually to Archer's 'consensus of informed opinion' (or, as it was more usually termed, 'nursing opinion') or to the television survey.

Several documents, prepared over the following four months to back

---

[23] Royal College of Art, Studies in the function and design of non-surgical hospital equipment Report No17, *General Purpose Hospital Bedstead: summary of analyses leading to user specification*. Much of the data amassed had been collected in the military context. A small amount came from work done in the furniture industry, on seat heights, for example. AA/1989/9, Job 7, Document 986, 'USA anthropometrics general' and Document 1307, 'UK anthropometrics general'.

up the specification, provide insight into the team's methods. They were amalgamated into a report summarising the 'analyses leading to user specification, May-August 1964'.[24] In line with the stages in Archer's 'Systematic Method for Designers', 'crucial issues' in bedstead design had first been identified. These comprised: future trends in patient care, manoeuvrability, operability, stability, ease of cleaning and of maintenance, and appearance. The source was 'nursing opinion'. Four 'constraints on development were noted: 'national and statutory, economic, materials limitations and environmental'. Six 'purposes of a bed' were listed. They were:

'To provide means for the patient to adopt a comfortable posture, necessities of warmth, protection, etc, to render the patient accessible for effective nursing, provide privacy, a familiar environment and an identifiable personal home'.

There then followed the now familiar lists of bed usages, or 'roles which a bed may perform', (increased from fourteen to seventeen) of bed elements and of the attributes required to describe them (such as size, structural performance, etc.) There were also two new lists. The first was a refinement of a working document first produced in June 1964, headed 'Bed usage and critical factors in design'. The list of roles performed by the bed or 'usages' was expanded by addition of the activities each involved. Against each of these 'usages' and their constituent activities was placed a list of 'critical factors in layout'. Against 'bed as a focus of nursing', for example, six critical factors were listed: 'high height, leg and foot clearances, width, tucking in perimeter, obvious mode of operation and

[24]Royal College of Art, Studies in the function and design of non-surgical hospital equipment, Report No 17, *General Purpose Hospital Bedstead: analyses leading to user specification*, May-August 1964.

obvious state of adjustment'. Against 'bed as an examination table' was 'height adjustment, high height, length, obvious mode of operation, all round access, stability, sitting support, backrest support and neutrality (of colour). For the usage, 'bed as a social centre', there were 'no critical factors, main factor is general appearance'.

The critical factors had been ascribed by the designers as 'the features which a mechanical object would have to have to support the role'.[25] The ordering of the list of activities/usages was no longer random, but determined by placing those with a higher number of relevant critical factors above those with less. In the final list, headed 'Design factors extracted and ranked' the critical factors themselves were ranked, according to how many bed usages they were relevant to. Thus 'stability' was first on this list because it was relevant to eleven of the bed's seventeen usages. Second came adjustable height, relevant to nine usages: as a focus of nursing, examination table, treatment table, workbench, focus of emergency, place for excretion, place for daily toilet, focus

[25]Interview, Kenneth Agnew, 22.6.00.

of ambulation and as an (un)loading surface. The first sixteen critical factors on the list were:

Stability
Height adjustment
Obvious mode of operation
Retention of mattress
Sitting support
Length
High height
Stable immobilisation
Leg and foot clearance
All round access
Width
Obvious state of adjustment
Drainage
Backrest support
Access to immobilising device
Tilt

all relevant to between twelve and six usages. Twenty five further factors were listed, the final five being relevant to only one bed usage each. The precise significance of this ordering is unclear. Its final form was produced for the purposes of the Report four months after the early version which formed the basis of the draft user specification. At least one other intermediate version exists in the archives. In retrospect, Archer considered it had been 'just an indication of what the designer should pay most attention to'. He also, once again, stressed the importance of being able to 'back up our conclusions'.[26] It was used to determine the wording of the final specification, which used the word 'shall', for example, for statements concerning factors high on the list, and 'should' for those lower down. Successive versions of the list show 'adjustable height' gradually rising to occupy a position second only to 'stability'. Some factors, notably

[26]Interview, Bruce Archer, 9.5.00.

'adjustment by the patient', subsequently failed to materialize at all in the specification.

The draft specification was widely circulated by the King's Fund. In essence it described a hospital bed of certain dimensions which was height adjustable, probably by means of a foot pedal, the foot end of which could be tilted over a large range at any height. The mattress base was to be rigid and continuous. A backrest element capable of supporting the patient's upper half at any angle to the horizontal was to be included. It was to have stowable safety sides and a bed stripper, castors suitable for travelling over continuous surfaces and be of antistatic construction.

Simulations

As noted above, the second phase of the project may be considered in terms of simulations of varying degrees of verisimilitude: both simulated beds and simulations of the real world. In the literature of operational research, and the management science derived from it, models and simulation were key concepts.[27] They were what the researcher working with 'real-life' problems employed in place of the controlled experiment in the laboratory. More than just hardware was modelled. Simulation involved modelling whole 'systems', such as military weapons or industrial plants. Occasionally, physical analogue models were used.[28] But ideally the

[27] See for example, Irwin Bross, *Design for Decision*, Toronto, Collier-Macmillan Canada Ltd., 1953, pp.161-182 and Rivett, *Concepts of Operational Research*, pp.14-33 and 140-157.

[28] One of the most well known was the 'cut out' map used to solve logistics problems in industry. The optimal location of a distribution depot was found by threading strings carrying weights proportional to the size of required deliveries through holes cut in the map at the delivery destinations. The strings were tied to a ring free to move across the surface

models were mathematical, an abstract expression of relationships, in which selected variables could be altered by the experimenter with ease in order to observe the effects. It was for problems which could not be wholly stated in mathematical terms that simulation was employed.

Simulating 'real life' underlay two important stages of the research for the King's Fund Bed project. The first grew out of dissatisfaction with observation in the wards as a means of analysing nurses needs with respect to hospital beds. It was considered that the hospital situation, in which junior nurses deferred to the views and instructions of seniors, obscured proper examination of their work with beds. Ideally, the RCA team would have liked to run a full-scale work study investigation, following recommended procedures in ergonomics.[29] These were complex, however, involving the wearing of masks for measurement of oxygen consumption, special clothing to allow for the recording of body positions and movements, and the time consuming repetition of procedures. Time was a resource in short supply, so a modified form of investigation was employed. Nurses from near-by hospitals were asked to come into the RCA and demonstrate bed making on adjustable wooden trestles. This was specifically to eliminate the effects of the social structure in which they worked. These sessions, largely recorded by photography, provided data for Kenneth Agnew, who was given the job of designing a prototype to the specification. Copies of this prototype were to allow for a second, much larger, controlled experiment involving simulation: a major field trial of the beds.

---

of the map. The resultant position of the ring, a product of the physical forces involved, indicated the optimal site for the depot. The method is described in Rivett, *Concepts of Operational Research*, p.21.

[29]Interview, Kenneth Agnew, 9.8.00.

First, however, a prototype had to be designed and built. It had not, in fact, been part of the RCA's remit to build a bed, merely to produce a specification. But it seems likely that Archer had this in mind from an early stage of the project.[30] The full implementation of his design method required the building and testing of a prototype design. He was careful to justify this expensive step in other terms as well, for example to prove that the specification could be met within a reasonable budget. (A reasonable budget was never specified). Subsequently, in a paper given in Vienna in 1965, he stated that the four reasons for building a prototype were:

> that it was an excellent discipline on research if one knew that one must produce a design in conformity with it at the end. Secondly it is an excellent discipline upon the existing manufacturers who would be less inclined to say the specification could not be met . . . thirdly, it was necessary to have at least one bed design exactly meeting the specification in order to carry out field tests in hospitals . . . (and fourthly) there would be no justification for such research to be carried out in a design school if no design was going to result.[31]

In a major article for the design press describing the RCA prototype, however, written by the Council of Industrial Design's purchasing officer, it was stated simply that 'it had always been the intention that the RCA team would design and build its own prototype', and that 'the cost of the bed had not been a predominant consideration at this stage since it was felt that the first priority was to arrive at a design which was an optimum interpretation of the user requirements set out in the specification'.[32] This description was

---

[30]At the first meeting of the Working Party attended by the RCA team, Archer outlined his plans for the research which culminated in 'a full-size prototype, in time for tests under hospital conditions to be well in hand by the end of 1964' A/KE/PJ/17/19 KFWPHB Minutes,17.3.64, Item 25.

[31]Quoted in Baynes, *Industrial Design and the Community*, p.48.

[32]Cousins, 'A general purpose bedstead for hospitals', p.54.

in line with Archer's view of the field trials as a controlled experiment. The prototype beds ('research tools') were to be placed in the real world, in a simulation of normal use.

At this point however, a more traditional form of model making took place, at first as an aid to the team's own discussions of how best to meet the specification, but later with an important role in advocacy. Four small-scale physical models were made. Each addressed the main engineering problem posed by the specification: how to achieve the range of height and tilt adjustment specified. One model represented a bed raised or lowered by compressed air. In retrospect this was regarded as having been a light-hearted suggestion.[33] Other models used rotary drive, that is the turning by hand of a worm screw, the rotary motion of which is converted into linear motion of the bed. This mechanism was already in use for raising beds and is similar to that used in car steering or for opening high casement windows. It was a time-consuming and relatively onerous way of altering bed height however, and there was evidence to suggest that nurses did not bother to adjust the height of beds already available which used this mechanism. A third, very simple, model represented the solution finally advocated by the RCA. This was the use of hydraulic power from a slightly modified lorry jack to raise the bed. The mattress platform was supported by 'scissor arms'. A self-locking telescopic linkage between these provided the tilt function.

Given that for Archer the design process was one of reconciling

---

[33] Inflatable structures were in fact of considerable interest in the 1960's, some of it in the Industrial Design (Engineering) Research Unit itself. A project there to devise inflatable play equipment for disabled children led subsequently to the commercial development of 'bouncy castles'. Interview, Gillian Patterson, 14.9.98. Other inflatables served more serious purposes; inflatable tanks were widely used in army manoeuvres.

conflicting demands, it is clear why the model stage was essential. The designer was to satisfy the maximum number of client/interest groups. Design models are without exception, highly selective in what they choose to represent. By and large, they tend only to represent what is at issue, what may prove contentious. What is deemed to be at issue will of course vary in different cases, according to how many assumptions are shared by the groups for whom they are made. For an architectural model, for example, the issues are to do with how a building will look, not whether it will protect people from the elements. This model represented only the height and tilt mechanism, contentious because it was by far the most expensive aspect of the specification, important to the RCA team because it was by far the most innovative one. This model, which reduced a highly complex and not yet worked out piece of engineering to a simple piece of moving geometry, was a literal reification of the issues, an advocate for the RCA's preferred solution, an assertion of 'doability'. The Working Party were persuaded, with the aid of this model, to accept further development of Agnew's prototype, but they 'took some convincing'.[34] It was not only the eventual cost of beds meeting the specification that was at issue. The cost of the project itself was coming under scrutiny.

The technical details of the prototype designed by Agnew (see page 7) were described as follows:

> The bed is constructed of welded steel. The lower chassis is of square section tube, sewn and arc welded. The moving arms, deck and superstructure are of thin sheet steel . . . This is power guillotined to shape and formed on a brake press into angles, trays and channels. These components are assembled into light, rigid box units by spot welding. Plywood jigs were used in making all the welded assemblies. There is a small number of machined components. Most of the bearings are plain with large assembly tolerance and

[34] Interview, Kenneth Agnew, 22.6.00.

> little need for lubrication, the bearings for the pedal drive are PTFE/lead used without lubrication. The finish is an acrylic enamel made by ICI. It is sprayed on and then stoved.[35]

The most obvious differences from conventional hospital beds were the scissor mechanism for height and tilt which supported the mattress platform, the boxed in mechanism beneath the platform which enclosed the jack, and the large, solid backrest with pillow straps.

Archer had first introduced the King's Fund working party to the ideas of hospital trials in March 1964, just before the first draft specification was produced. At that time he had mentioned tests of 'a full-scale prototype' under hospital conditions.[36] In August, as Agnew's prototype neared completion, he reported that 'some thought had been given to the question of how new patterns of bedstead should best be tested under hospital conditions.'[37] At the same meeting, S. E. Harrison, Work Study Officer for the North East Thames Metropolitan Hospital Board was invited to report on two trials of hospital beds with which he had been involved.[38] At the next meeting, in October, Archer reported that Reginald Talbot, of the College of Aeronautics at Cranfield 'would continue to plan field trials of the prototype'. And at a meeting of the Working Party a month later, a Plan for the Remainder of the Enquiry was presented:[39]

---

[35] AAD/1989/9, Job 1, Agnew to Halls, 17.12.75.

[36] A/KE/PJ/17/19 KFWPHB, Minutes, 17.3.64, Item 25.

[37] A/KE/PJ/17/19 KFWPHB, Minutes, 20.8.64, Item 55.

[38] From 1960, the MOH allowed each RHB one work study officer charged to Exchequer funds. Some employed additional officers from their own resources. Considered innovative around 1960, as the decade wore on Work Study was more often involved with bonus calculation and contracting out of services. Anon., 'Hospital Work Study makes progress', *British Hospital and Social Service Journal*, April 12, 1963, p.417.

[39] A/KE/PJ/17/19, KFWPHB Minutes, 4.11.64, Item 70.

The Working Party was reminded that in issuing its design specification it had achieved the main object which had been agreed at its first meeting but that the ultimate purpose of the study would only be accomplished when a few approved patterns of bedstead were available for supply to hospitals at a price acceptable to the Ministry of Health.
The next step should therefore be the confidential scrutiny of each design prepared to the Working Party's specification, preferably embodied in prototype form, so that those likely to result in satisfactory bedsteads could be chosen for trials under ward conditions. For this purpose an adequate sample quantity of bedsteads made to each design would have to be tested, and the results should be used in the revision of the specification and in the final selection of designs qualifying for the approval of the Ministry.[40]

At the same meeting, it was noted that although:
. . . no grant would be available from the Fund to meet the cost of this development programme . . . Mr Hunt considered it likely that the necessary commitments could be met from the Ministry's resources and assured the Working Party of his co-operation for this purpose.

The Minutes of this stage of the project mask considerable reservations on the part of senior officials of the Fund, and several months of behind-the-scenes activity. Archer, aware that the Fund was increasingly concerned about expenditure of time and money, had approached the Ministry of Health directly late in 1964. Feelings were running high on both sides. After a meeting with Hunt, together with Davies and Howes from Supplies Division, Archer reported to Misha Black that
. . . all three regard the Working Party as a gathering of eccentrics who are not only most unrepresentative of the hospital service but also liable to gallop off in all directions at a moment's notice. Mr Davies said that they would have produced nothing without our intervention. Proprieties demanded, however, that the development of an agreed bedstead specification (and a very small number of standardised designs) be done through the Working Party if it is humanly possible. Mr Hunt says that he must not be seen too clearly as leading, even from behind. He . . . would particularly welcome a programme for implementation of the design and field trials as set

[40]Ibid.

> out in my memorandum. The Ministry would order and pay for up to 200 trial beds and organise the manning of the team of observers . . . I pointed out that the King's Fund were threatening to withdraw or reduce their support. Mr Hunt and Mr Davies looked at one another and said they were sure they could get over that problem . . . there were precedents even for direct support. Since the Working Party has neither staff nor funds to carry out the field work itself, there should be no difficulty in persuading them to appoint agents to do the work and then meet in (say) six months time to endorse the results . . . It occurs to me now, in retrospect, that it is quite extraordinary for the King's Fund to think of cutting down on our activities just when they are about to yield spectacular dividends.

The practical results of this meeting were that the MOH agreed to fund the manufacture of twenty copies of the RCA prototype, and underwrite hospital trials to the tune of £20,000. Senior officials at the Fund were not pleased. Hall, the Director of Hospital Services, attended a meeting of the Working Party a few weeks later to make his views known:

> The Fund had paid the RCA a total of £13,200 . . . later it was suggested field trials were necessary . . . now MOH O&M people were talking of £20,000 (for these). Where was it going to end? He rejected the view that it was the Ministry's own business if they wanted to spend £10,000 or £20,000 on field trials, or that it was something to be grateful about. The Fund would under no circumstances give the RCA more than a further £2,500 to complete the studies . . .'[41]

The disagreements at this stage of the project are closely related to the interests of the various parties. The King's Fund's greatest asset was perhaps its reputation. Its judgement, and its financial management, were held in high esteem by the London medical world. It was not accustomed to pouring large sums of money into seemingly bottomless pits. Archer, understandably, was intent on pursuing his method to its conclusion; opportunities to carry out an experimental design project of this scale and

[41] AAD/1989/9, Job 13, Main Box. Report on Working Party Meeting of 3.3.65, dated 5.3.65.

expense were likely to be few and far between. He and Hunt found common ground in their impatience with the Working Party, who may have been 'unrepresentative of the hospital service', but who were probably, for Hunt at least, all too representative of Hospital Management Committees throughout the country. Each of the members was, had been, or might easily have been invited to become, a member of an HMC. But Hunt had more pressing reasons to support Archer's field trials. His next appearance before the Public Accounts Committee was imminent, scheduled for February 1965, and he wanted to be able to report at least some progress towards the drawing up of equipment standards.[42] From this point, MOH officials became closely involved 'on the ground'.

Twenty copies of the prototype were required for the trial and tenders were received from half a dozen companies. Only two were established in the medical field (Barnet Medical Developments and Hospital Metalcraft). Two were aircraft manufacturers, and the larger of these, Scottish Aviation, was awarded the contract in March 1965 on the basis of a unit price of £200 for twenty beds or £75 for a thousand.[43] Based at Prestwick, Scottish Aviation were seeking to diversify in the face of reduced demand for military aircraft. The twenty beds were built in space freed by the cancellation of the TSR2 project.[44] Their facilities impressed the inspector sent from the Ministry of Health's Technical Services Branch. Their engineering range was 'very wide . . . from close tolerance machine

---

[42]AAD/1989/9, Job 7, memo, 29.10.64.

[43]AAD/1989/9, Job 13, List of Companies submitting tenders.

[44]The TSR2 was designed to carry airborne nuclear weapons. The project was scrapped in Denis Healey's £56 million defence cuts announced in January 1965. Morgan, *The Peoples Peace*, 1990, p.249.

work on Rolls Royce engine castings to body building and fitting for ice cream vans.' 'As an aircraft firm looking to diversify', he added, 'Scottish Aviation are keen to please.'[45] Kenneth Agnew and Ministry of Health engineers made several visits to the factory during production and the twenty beds were completed relatively unproblematically.

It had been agreed that Scottish Aviation could change 'materials, sections and detailed construction, provided general geometry remained the same and function was unaffected'. It was anticipated that their engineers might suggest alternative means of construction, such as the use of Bowden cables or other technologies common in the aircraft industry. In the event they suggested only 'variations in detail', and what amounted to twenty copies of Agnew's prototype were produced. 'What we ended up with', he was later to observe, 'was a set of theories dressed up as a finished product'.[46] In line with his view of the trials as a controlled experiment, Archer preferred to describe these beds as 'not an attempt at a design solution, but a research tool'. They were to be placed in a simulation of the real world, very similar to it in physical and behavioural terms, but less so in cognitive and social aspects. In addition, an attitude survey of patients and nurses was planned, together with morale and efficiency testing of nurses at Manchester University and energy expenditure of nurses at Edinburgh University. In the event, only the first of these was completed.

Prior to the trials, what Archer referred to as prime facie

---

[45]AAD/1989/9, Job 13, Dean, Technical Services Branch, notes of a visit to Scottish Aviation, 22.6.65.

[46]Kenneth Agnew, 'Inventors and Inventiveness', lecture notes for Hatfield College of Technology, 22.4.68.

assessment of a single bed was carried out at the Westminster Hospital School of Nursing. Here 'Preliminary Validation Studies' were organised by the Work Study Department. There were resulting modifications to the backrest. The lock was removed, and rubber feet and a handle added to the base.[47]

The second phase of evaluation, comprising the field trials, took place at Chase Farm Hospital in Enfield. The North West Regional Board had an active Work Study team under the leadership of S.E.Harrison, who had already spoken to the King's Fund working party about evaluating hospital beds. The matron, Mary Larret, had recently arrived from the relative sophistication of a London teaching hospital. If these practical matters influenced the choice of hospital, more theoretical ones dictated the type of ward selected. A women's surgical ward was chosen as providing the most wideranging test of the prototype. I shall return to this issue in Chapter Six.

The trials began on 20 September 1965. The procedure, worked out with the assistance of Harrison and Talbot involved a team of 'trained observers', most of whom were retired nurses, recording all activities involving ward beds from 6am until 10pm for a period of 5 months. For the first month the original ward beds were used. After this the new beds were substituted for 3 months, then the old ones returned for a further month. Observations were of two kinds: continuous, recording every incidence where attention was given to patients, and 'random', whereby the position of the movable elements of the bed were recorded at particular intervals. Both categories of observation were recorded as numbers, the continuous

---

[47]AAD/1989/9, Jobs 7 and 13, Trial Reports, Report on preliminary validation studies.

resulting in a 23 digit number, and the random a 37 digit number, which could be transferred to punched cards or tape. The trials were completed in January 1966, but there was substantial delay in the computer analysis that followed.

The use of a computer to analyse the trial data was clearly of considerable importance to Archer in terms of the portrayal of the project, as well as the potential it gave for comparing large numbers of variables. In their published material, and in communications to the working party, the team took every opportunity to stress that the most powerful computer in the country was being used to handle the huge quantities of information generated by the investigation - invariably given as numbers of individual 'pieces' or 'items'.[48] The computer in question was the University of Manchester Institute of Science and Technology (UMIST) Atlas. A. J. Wilmott, of the Department of Computation, was engaged to write the necessary programme. His analysis of the trial results dragged on into the summer. There were practical problems over getting the punched cards, prepared by a data processing company, to Manchester in the pristine condition required by the computer. Early batches had to be redone, and special containers purchased. Wilmott disagreed with Archer over the form in which the computer should produce results, complaining in July 1966 that:

> The analysis so far has involved producing as much printed material as Dickens wrote into his novels. If a human being needs to look at, say, 500 tables, then a computer could do equally as well, provided the programmer was given adequate warning.[49]

---

[48]'No fewer than one and three quarter million separate pieces of information' were said to have been produced by the trials and validation studies. King's Fund, *Design of Hospital Bedsteads*, p.10.

[49]A/KE/PJ/17/1, Wilmott to Roberts, 5.7.66.

The King's Fund, mindful of the time and money expended, grew increasingly restive. The Chairman of the Working Party was heard to enquire, albeit while drinking sherry, 'Why a computer was essential, and what it could do that could not be done by someone with an adding machine?' At the same function another member opined that, as far as he could see, 'you feed a lot of garbage in and you get a lot of garbage out'.[50] Eventually, however, the analysis was completed. Archer had requested that the computer be asked to compare 'every variable with every other variable'. For example, it would show how' often a patient got out of bed' varied in relation to the height of the bed. Each table was subjected to a significance test and it was anticipated that 'attitude studies and prime facie assessments (would) help direct attention to the most interesting relationships'. The team received the results in the form of columns of numbers which, for want of any other means, they resorted to pinning up all over the walls of a small room to see whether they could visually detect significant correlations. This was to answer three vital questions about the bed design: 1.Does it fulfil the specification? 2. Does the specification correctly describe the user's needs? and 3. Is the ward-patient-nurse system created by the use of the new specification markedly better or worse than existing systems?[51]

It is questionable whether the computer analysis produced the results for which Archer hoped. Certainly it was answers to the third question that might prove most useful in promoting the specification. But,

---

[50]AAD/1989/9, Job 13, Gillian Patterson, Report on a meeting of the Working Party at the Hospital Centre, 1.8.66.

[51]Quoted in Baynes, *Industrial Design and the Community*, p.50.

on the question of reducing in-patient stays, for example, Harrison wrote to Gillian Patterson that 'the variations in length of stay month by month are startlingly large and clearly mask any effect which the new bed might have had'. The primary value in using a computer was probably rhetorical, especially among audiences alive to the growing role of computers in science and their potential role in management, including hospital management. Each of the professionals involved was anxious to bring credence to their particular disciplines. The sociologist who carried out the attitude survey wrote that:

> As a consumer survey this is probably one of the first of its kind since the introduction of a nationalised health service. Using the tools and concepts of sociology it has drawn to attention some features of hospital life which have been hitherto ignored or neglected . . . Above all it has helped to show how research methods in the social sciences can be used to help in solving hospital problems.

But the small numbers of individuals questioned made the results of questionable value in what was then normal practice in survey technique. The nurses interviews were difficult, 'only thirteen had worked regularly with the new beds and one refused to answer any questions at all'. Interviewing the patients was difficult, too, 'Privacy was not always possible — frequently other patients would shout out their own opinions'.

The report noted that 'Nurses liked the idea of the height adjuster but some day and all night nurses complained that they did not have time to use it.' The Report's summing up nurses attitudes was that 'the bed had some good features but they were put together wrongly'.Both Wilmott and Harrison published accounts of the trials, from the perspective of computing and work study, and both expressed the view that such techniques would become widely used, but there is no evidence that this

was the case.[52] For some contemporaries, they were a 'sledgehammer to crack a nut'.

The Chase Farm trials had, however, a different kind of outcome in terms of modifications to the design of the bed. These were classed as 'mechanical failures' which needed attention. The jacks fell too fast, the pull-out backrest was too awkward and the rising base was vulnerable to damage in its upper quarter. The observations which led to identification of these 'mechanical failures' were clearly regarded as different from the observation of interactions in the 'nurse-patient-bed' system. In part this was because what was being looked for in this 'system' were measurable effects of the 'bed as a whole' on wider issues. Did the new beds reduce length of patient stay? Did they encourage early ambulation? Did they reduce sick leave among nurses? It was the former type of question, however, that was of immediate interest to any potential manufacturer.

---

[52] J.M. Haile and S.E.Harrison, 'Two views of the King's Fund Bed, I - Trials and Results', *British Hospital and Social Service Review*, May 5, 1967, pp.814-816, S.E. Harrison, 'Bedsteads on Trial', *Hospital Management, Planning and Equipment*, 30, May 1967, pp.245-7. A. J. Wilmott, 'Use of a computer in hospital bed design', *Hospital Management. Planning and Equipment,* 30, May 1967, pp.247-250.